Space Weather Technical Forecast

Issued on Sunday, 12 February 2023 at 13:01 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of X-flares with M-flares (R1/R2 Radio Blackouts) expected. Chance of G1/Minor Storms on days 2 and 3.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High with an impulsive X1.1 flare observed from AR3217, currently Ehc/Beta-Gamma-Delta in the southeast disc, peaking at 11/1548 UTC. This is a complex but relatively small and compact region with ongoing evolution of its surrounding spots. There are thirteen sunspot groups on the disc, with three further M-class flares and multiple C-class observed in the last 24 hours. These mainly from AR3217, but also the smaller region AR3222/Dso Beta now crossing the west limb, along with AR3220 Hsx/alpha to the south east of AR3217.

No significant CMEs currently detected with available imagery during the last 24hr.

Solar Wind / Geomagnetic Activity: Solar winds continued to be slightly elevated, with observed speeds at L1 ranging between 460-530 km/s. The density remained around average to below average. Total IMF strength, Bt, was mainly weak, below 7nT, with the north-south component variable between -5nT and +5 nT. Phi angle generally negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 remained at Background. The high energy electron flux (greater than 2MeV) measured by GOES-16 was mainly Moderate, peaking at 840pfu at 11/1425 UTC. The associated 24-hour electron fluence was below Active reaching 4.33e7 integrated pfu at 12/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: High to Moderate activity forecast with further M-class flares expected and a chance of X-class flares. The main risk from AR3217 currently.

Solar Wind / Geomagnetic Activity: Glancing Earth-directed components possible from CMEs associated with filament eruptions on the 10th and 11th, giving low confidence for the geomagnetic forecast, with a chance of glancing interactions on day 2 and 3 (13th/14th). Aside from these CMEs, current slightly elevated solar winds are expected to only erratically ease, with no significant enhancements expected.

Geomagnetic activity is currently expected to be mainly Quiet to Unsettled. Perhaps rising to Active with a chance of G1/Minor Storms on days 2 and 3 (13th/14th).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, but with a slight chance of rising in response to any significant flares. High energy (greater than 2 MeV) electron flux is expected to be at Background to Moderate levels, with an overall declining trend.

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The associated 24 hour fluence is expected to remain below the Active threshold (1e8 integrated pfu)

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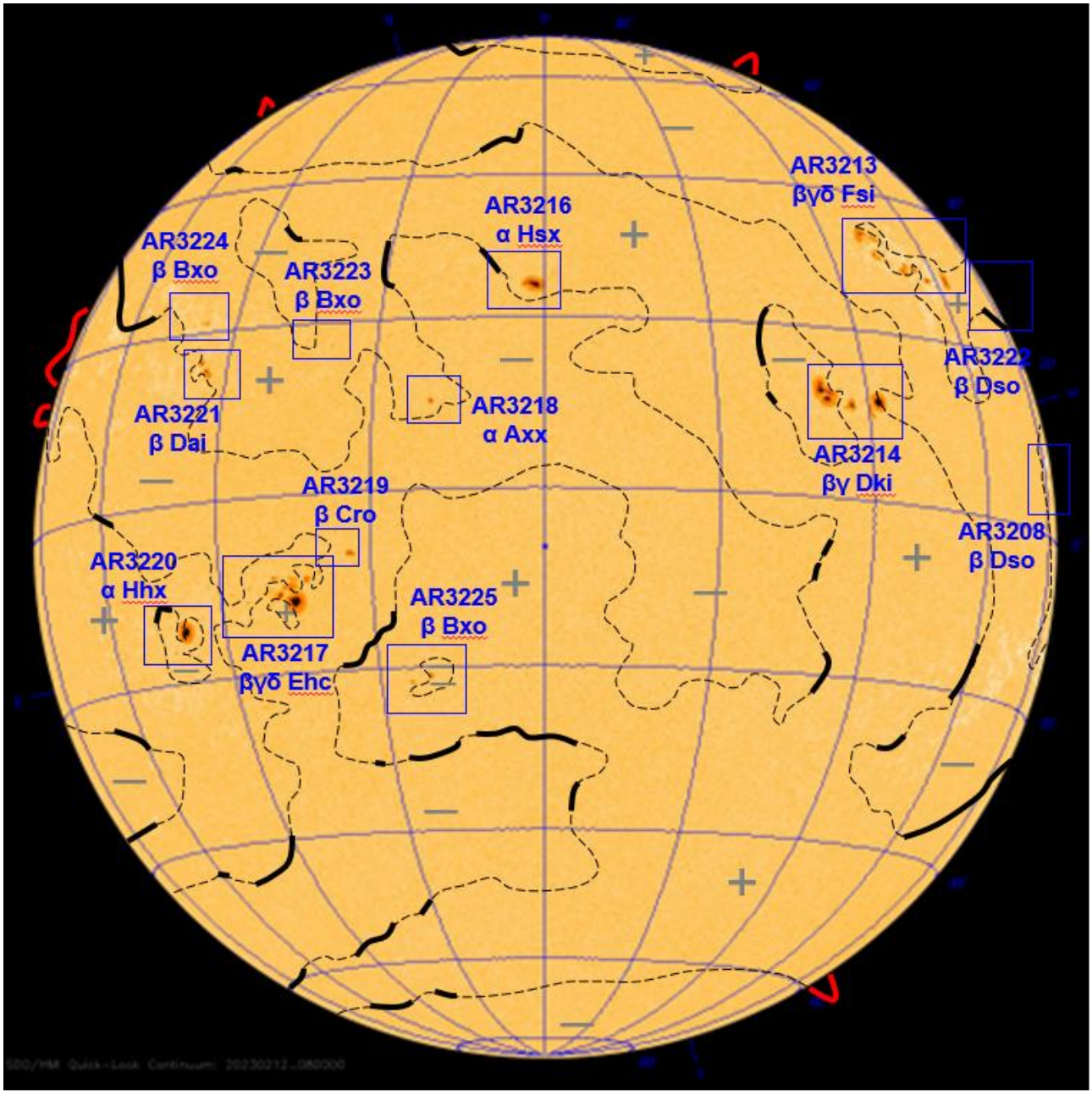
Figure 1. Solar Analysis Valid 12/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament eruption observed in the north center disc on around 11/1050 UTC produced a fast northward directed CME that is expected to largely miss Earth, however glancing effects look to be possible into day 2 (13th) or early day 3 (14th). There is also a further CME which occurred due to a filament lift off in the southwest disc on the 10th. This produced a wide, but slow CME, and is again likely to miss Earth, passing ahead and to the south of it on the 14th. However this may also glance Earth.

This means that despite no coronal holes being present on the Earth-side of the disc, and ENLIL giving generally good guidance for continued slightly elevated solar winds in the absence of any CME arrivals, the geomagnetic forecast is currently low confidence.

Geomagnetic activity is therefore currently expected to be mainly Quiet to Unsettled. Perhaps rising to Active with a chance of G1/Minor Storms on days 2 and 3 (13th/14th) due to glancing impacts associated with the above mentioned filament CMEs from the 10th/11th, with the risk reducing into day 4 (15th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	30	30	10
Strong	G3	No	1	10	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/1257	Partial Halo	Filament Eruption	NE disk	1700	14/0100UTC	Glancing blow, low confidence

Figure 2: SOHO LASCO C3 (left) and difference imagery (right) associated with filament eruption on the 11th, northwards directed CME visible but potential also for a faint halo. Low confidence.

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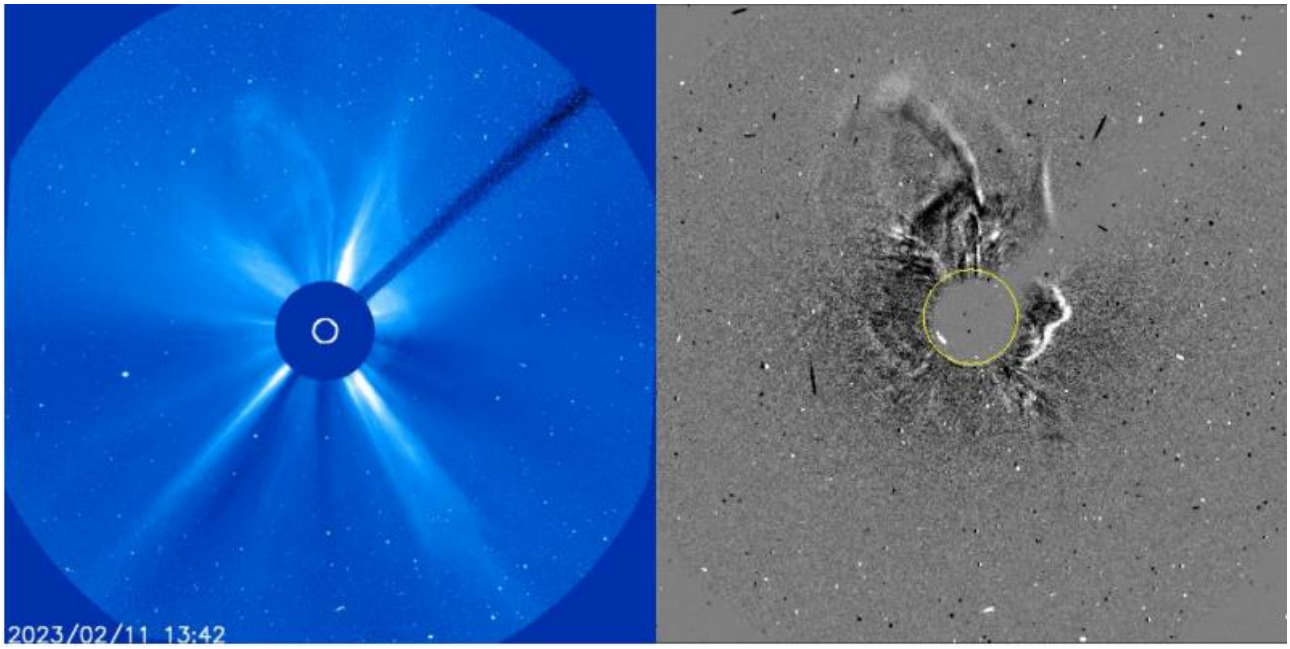

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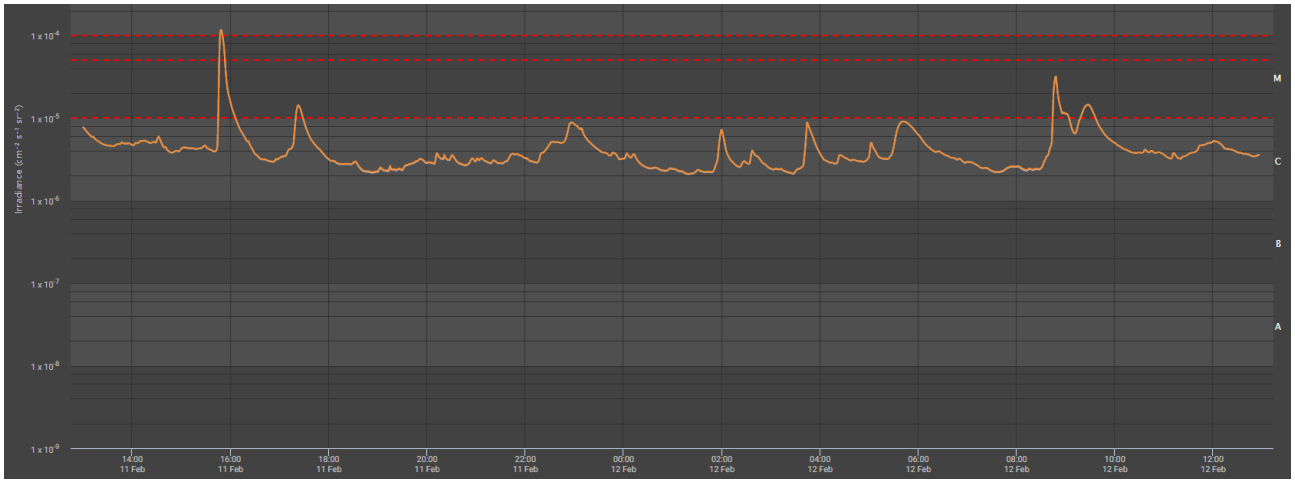
Radio Blackouts - X-Ray Flares:
Moderate to High activity is expected, with thirteen regions currently on the Earth-facing disc. M-class flares are expected with a chance of X-class flares.

The most active region is AR3217 Ehc/Beta-Gamma-Delta in the southeast, which produced an impulsive X1.1 on the 11th. This is a modestly sized but compact region with a small delta spot to the northeast of its main leader, and given its history of X-class flares, similar sized flaring remains possible. AR3213 Fsi/Beta-Gamma-Delta in the northwest which been a source of numerous M-flares also maintains small delta spots, with the potential for further activity. AR3214 Dki/Beta-Gamma is also of note, as another moderately sized region in the northwest. Despite its relative inactivity and simple bipolar configuration, it has seen development of small intermediate spots. All other regions are generally smaller and simpler, although M-flares have been observed from regions near the northwest limb, with further isolated M-flares possible from these regions as they rotate off the visible disk over the next day or so.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	70	60	50
Very Active	R3 to R5 X Class	Yes	30	20	15	10

Figure 3: GOES 18 X-ray trace for the last 24hrs



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Solar Radiation Storms - (High Energy Protons):
High energy (greater than 10MeV) proton flux as observed by GOES16 is currently at background levels. No notable high energy proton response has been observed from M-flares or the X-flare on the 11th. Any further significant flares will give a chance of count rates increasing, with a slight chance of exceeding the S1 level. While AR3213 will rotate off the disc day 3 (14th), the proton risk is maintained as AR3217 will have moved into a more favorable location for Earth-directed events.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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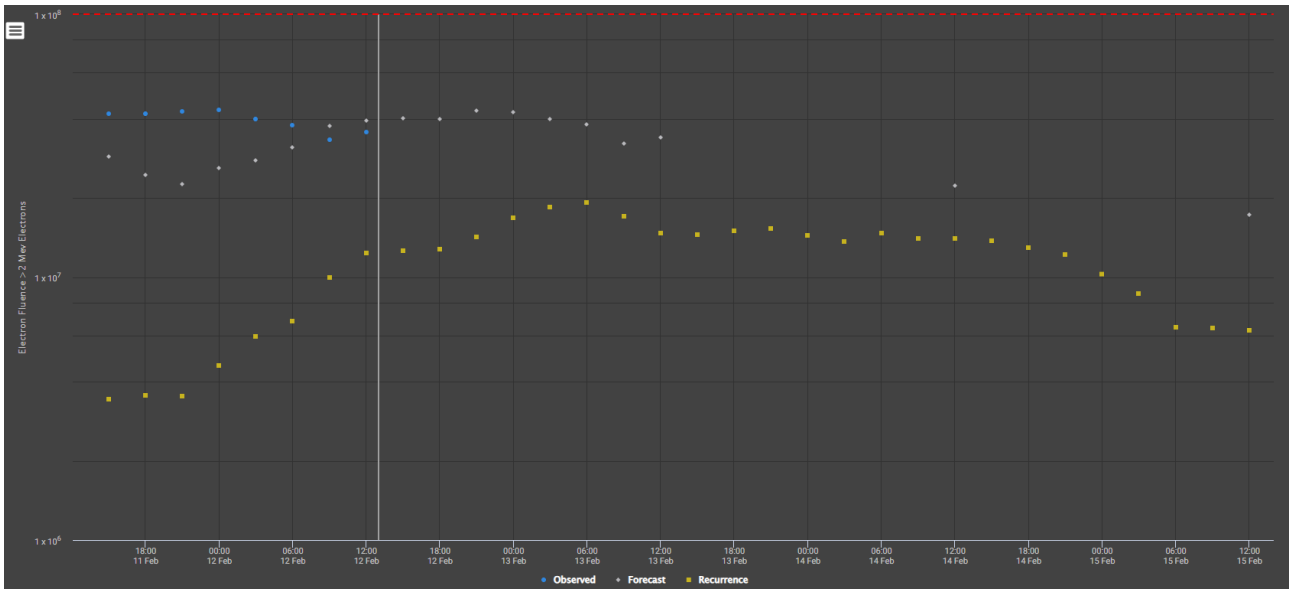
High Energy Electrons Event (≥ 2MeV):
The high energy (greater than 2 MeV) electron flux at GOES-16 is expected to continue at Background to Moderate levels with no further notable enhancement expected. Peak values are likely to gradually and erratically decline towards background.

The associated 24 hour fluence is expected to remain below the Active level. This is supported by REFM, which is currently giving good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Latest Met Office REFM model output.



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